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IMPROVING EGYPTIAN COTTON USING F_2 QUADRIALLEL CROSSES

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ABSTRACT

The aim of this investigation was to estimate combining abilities for yield, yield component traits and fiber properties in cotton. The genetic materials used in the present study included 45 F_2 double crosses. In 2010 growing season, these genotypes were evaluated in a field trial experiment at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate for the following traits: seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), boll weight (BW), lint percentage (L.%), fiber fineness (F.F), fiber strength (F.S) and upper half mean (UHM).

The results showed that the mean squares of genotypes were highly significant for all studied traits except (L. %)., the partitioning of the double crosses mean squares to its components showed that the mean square due to 1-line general, 2-line specific, 2-line arrangement, 3-line arrangement and 4-line arrangement were either significant or highly significant for most studied traits.These results suggesting the presence of the additive and non-additive genetic variances in the inheritance of these traits . The parents Giza 86 (P_1) and TNB1 (P_2) were the best general combiner for most studied yield component traits and fiber properties . The parental variety C.B 58 (P_4) showed positive and desirable values of general combining ability among parents for fiber fineness (F.F.) . The parent Giza 85 (P_5) was good combiner for lint percentage, while, the parent Suvin (P_3) was the best combiner for most yield component traits.

Concerning the two-line interaction effect, (S^2_{12}), (S^2_{13}), (S^2_{15}), (S^2_{23}) and (S^2_{46}) showed positive (desirable) effects for most yield components. Moreover, the best combinations for (F.F) were (S^2_{12}), (S^2_{35}) and (S^2_{46}). Also, the best combinations for (F.S) and (UHM) were (S^2_{16}), (S^2_{23}) and (S^2_{46}), respectively. The three-line interaction effect cleared that the combinations (S^3_{123}), (S^3_{125}), (S^3_{135}) and (S^3_{235}), (S^3_{246}), (S^3_{456}) showed great positive (desirable) effects for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.). In the same time, (S^3_{135}), (S^3_{145}), (S^3_{146}), (S^3_{156}), (S^3_{236}) and (S^3_{246}) were the best combinations for (F.S)**,** while (S^3_{123}), (S^3_{156}), (S^3_{234}), (S^3_{246}) and (S^3_{346}) for (UHM) as well as [(S^3_{123}), (S^3_{124}), (S^3_{146}) and (S^3_{235})] for (F.F) property. Furthermore, the four-line interaction effect revealed that the best double cross combinations for (S.C.Y. /P.), (L.Y. /P.) was (S^4_{1235}). Moreover, (S^4_{2456}), (S^4_{1345}), (S^4_{1246}), (S^4_{1256}) and (S^4_{1456}) were the best double combinations for (B.W), (L. %), (F.F), (UHM) and (F.S), respectively.

The specific combining ability effects t^2(ij)(..) showed that the combinations t^2(16)(..), $t^2_{(24)}$(..), $t^2_{(56)}$(..), $t^2_{(36)}$(..), and $t^2_{(15)}$(..) were the best combinations for (S.C.Y. /P.), (L.Y. /P.), (L. %), (B.W), (F.F), (UHM) and (F.S) traits, respectively. In conclusion, from the preivous results it could be concluded that the combinations [(P_1 x P_2) x (P_3 x P_5)] and [(P_1 x P_2) x (P_4 x P_6)] appeared to be the best promising double crosses for breeding of yield traits .

In general, [(P_1 x P_5) x (P_2 x P_4)], [(P_1 x P_5) x (P_3 x P_6)] and [(P_2 x P_4) x (P_3 x P_6)] would be good combinations for most studied yield and fiber traits. Meanwhile, [(P_1 x P_4) x (P_2 x P_3)], [(P_1 x P_4) x (P_5 x P_6)] and [(P_2 x P_3) x (P_5x P_6)] would be the best for most studied yield traits and fiber strength (F.S.) property. In addition, the combinations [(P_1 x P_6) x (P_2 x P_3)], [(P_1 x P_6) x (P_4 x P_5)], [(P_2 x P_3) x (P_4 x P_5)] and [(P_2 x P_5) x (P_4 x P_6)] appeared to be the best promising for upper half mean (UHM) property.The results revealed that the magnitudes of dominance genetic variance

(σ^2D) were positive and larger than those of additive genetic variance (σ^2A), for most studied traits. Concerning epistatic variances, additive by dominance genetic variance (σ^2AD), additive by additive genetic variance (σ^2AA) and additive by additive by additive genetic variance (σ^2AAA) played a major role in the inhertance of yield components and fiber properties traits. This finding may explain the superiority of most studied double crosses than their parents in most of yield components traits. Therefore, it could be recommended that production of double crosses to involved in the selection breeding programs is the desirable way for improvement these traits.
Keywords: Cotton, Quadriallel analysis, Gene action and Combining abilities.

INTRODUCTION

Double cross hybrids were known to perform quite well under a wide range of environmental conditions (Sujlprihatp *et al*., 2003). Double crosses analysis provides information about nature of gene action of studied traits. The genetic components which were valid in these analyses are additive, dominance and epistatic variances. The epistatic variance include additive x additive (σ^2AA), additive x dominance (σ^2AD), dominance x dominance (σ^2DD) and additive x additive x additive (σ^2AAA) component of variance. This technique also gives information on the order in which parents should be crossed for obtaining superior recombinants (Singh and Narayanan, 2000). A double cross or a quadriallel is the first generation progeny of the crossing between unrelated F_1 hybrids viz., (a x b) (c x d) where a, b, c and d are the four parents and a x b and c x d are the two unrelated F_1 hybrids involving these parents. Taking ‘P’ as the number of parents, all possible double crosses would be 1/2P (P – 1)(P – 3). The theoretical aspect of quadriallel analysis has been dealt with by Rawling and Cockerham (1962b).

Jagtab and Kolhe (1987) found that both additive and non-additive gene action played a significant role for the inheritance of bolls number/plant, boll weight, seed cotton yield and lint percentage. In the same time, Kumar and Raveendran (2001) cleared that both additive and dominance genetic variance components were detected for number of bolls/plant and boll weight in the studied crosses. Abd El-Bary (2003) revealed that the magnitude of additive genetic variance was positive and larger than that of dominance genetic variance with respect to all studied yield component traits. In addition, the results revealed that the three types of epistatic variance (σ^2AA, σ^2AD and σ^2DD) were contributed in the genetic expression of most studied traits except for boll weight, lint percentage and lint index.

Potdukh and Parmar (2006) indicated that yield and yield component traits exhibited low value of heritability. They added that, high estimates of (101.28) were observed for seed index followed by seed cotton yield (30.04). El-Hoseiny (2009) found that the parents Australian (P_1) , BBB (P_2), and P_4 had the highest negative value of 2-line general effect which had good specific combination of (P_1 x P_2)(--) and (P_2 x P_4)(--).When they set into another arrangement i.e. (P_1 x -)(P_2 x -) and (P_2 x -)(P_4 x-) ,showed the positive 2-line specific for most earliness traits with undesirable direction. Said (2011) found that moderate narrow sense heritability estimates was obtained from (30 -50) for yield and yield components while high narrow sense heritability for upper half mean (over 50%) .

Many investigators studied general and specific combining abilities among them; Hemaida *et al.* (2006), Ahuja and Dhayal (2007), Eman *et al* (2007) Basal *et al*. (2009) and Karademir and Gençer (2010) .

Thus, the present investigation was carried out to estimate combining ability and gene action for some yield components and fiber properties using quadriallel system of six cotton genotypes and to colect the information to improve Egyptian cotton in breeding programs using double crosses.

MATERIALS AND METHODS

The genetic material:

Six parents belonging to *Gossypium barbadense,* L., three of them are Egyptian long staple cotton varieties: Giza 86 (P_1), Giza 85 (P_5) and Giza 89 (P_6). The other three parents were TNB1 Sea Island (P_2) an extra long staple, Suvin (P_3) Indian long staple germplasm and CB-58 (P_4): American Egyptian variety, a medium long staple. The 45 F_1double crosses were selfed to produce their 45 F_2 generation . The F_2 genotypes were evaluated to study the nature of gene action in the genetic materials.

Experimental design:

In 2010 growing season, the 45 F_2 double crosses were evaluated in a field trial experiment at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The experimental design was a randomized complete blocks design with three replications. Each plot was one row 4.0 m. long and 0.7 m. wide. Hills were 0.4 m. apart to insure 10 hills per row. Hills were thinned to keep a constant stand of one plant per hill at seedling stage. Ordinary cultural practices were followed as the recommendations.

Data were recorded on the following traits: boll weight in grams (B.W.g.); Seed cotton yield per plant in grams (S.C.Y. / P.g.); lint yield per plant in grams (L.Y./P.g.); lint percentage (L %) and fiber strength (F.S.), fiber fineness (F.F.) and upper half mean (UHM) as a measure of Span length in mm. The fiber properties were measured in the laboratories of Cotton Fiber Research Section, Cotton Research Institute according to (A.S.T.M.D-1448-59, D-1445-60T and D-1447-67).

Biometrical analysis:

Statistical procedures used in this study were done according to the analysis of variance for a randomized complete blocks design as outlined by Cochran and Cox (1957).

Considering $Y_{(ij)(kl)m}$ as the measurement recorded on a double cross $G_{(ij)(kl)m}$ the **statistical model takes the following form:**

$Y_{(ij)(kl)m} = \mu + r_m + G_{(ij)(kl)} + e_{(ij)(kl)m}$

Where:

$Y_{(ij)(kl)m}$: the observation on double cross (ij) (kl) grown in replication m, m = 1, …; r, i, j, k, l = 1, …; p where no two of i j, k, and l can be the same

μ : the general mean

r_m: effects of replication *m*.

$G_{(ij)(kl)}$: the genotypic effect of the double cross hybrid (ij) (kl)

$e_{(ij)(kl)}$: a random error.

Further, $G_{(ij)(kl)} = (g_i + g_j + g_k + g_l) + (s_{ij} + s_{ik} + s_{jk} + s_{il} + s_{jk} + s_{jl} + s_{kl}) + (s_{ijk} + s_{ijl} + s_{ikl} + s_{jkl}) + (s_{ijkl}) + (t_{ij} + t_{kl}) + (t_{i.k} + t_{i \cdot l} + t_{j \cdot k} + t_{j \cdot l}) + (t_{ij \cdot k} + t_{ij \cdot l} + t_{kl \cdot i} + t_{kl \cdot j}) + (t_{ijkl})$

g_i : the average general effect of the line i

s_{ij} : the 2-line interaction effect of lines i and j appearing together irrespective of arrangement.

s_{ijk} : the 3-line interaction effect of lines i, j and k appearing together irrespective of arrangement.

s_{ijkl} : the 4-line interaction effect of lines i, j, k and l appearing together irrespective of arrangement.

t_{ij} : the 2-line interaction effect of lines i and j due to the particular arrangement (ij)(--).

$t_{i.j}$: the 2-line interaction effect of lines i and j due to the particular arrangement (i -)(j -).

$t_{ij.k}$: the 3-line interaction effect of lines i, j and k due to the particular arrangement (i j)(k -).

$t_{ij.k}$: the 4-line interaction effect of lines i, j, k and l due to the particular arrangement (i j)(k l).

Table 1: Form of the analysis of variance of the double crosses and expectation of mean squares.

S.O.V.	d.f	EMS
Replications	R-1	R.
Doble Crosses	[p(p- 1)(p-3)]/2 -1	H
1-line general	p-1	G
2- line specific	P (p-3)/ 2	S_2
2- line arrangement	P (p-3)/ 2	T_2
3-line arrangement	P (p-1)/2+1	T_3
4- line arrangement	P -1	T_4
Error	(R-1) [p(p- 1)(p-3) /2 -1]	E
Total	R[(p(p- 1)(p-3)]-1	

Where:

R : is number of Replications .
P : is number of Parents.
H. : is the double crosses (ij)(kl).
G. : is Total additive effects excpt a small portion contained in the error
S2 : Represent total dominance effects.
T2 : The effects arising due to the arrangment 2-Lines are exclusively the results of dominance effects or interaction involving dominance components..
T3 : Function of additive x dominance interaction including all 3-factor or higher order except all dominance types.
T4 : Represent dominance xdominance interaction and all 3-factor interaction except all additive types .

The theoretical aspect of quadriallel analysis has been illustrated by Rawlign and Cockerham (1962b) and outlined by Singh and Chaudhary (1985). The form of the analysis of variance of the quadriallel crosses and expectation of mean squares are presented in Table 1.

Estimation of combining Ability Effects:

1- $g_i = [Y_{i...} / (r\, p_1\, p_2\, p_3/2)] - \mu$ Where, $\mu = Y_{....} / (p_1\, p_2\, p_3/8)$

2- $S^2_{ij} = [Y_{ij..}/(3r\, p_2 p_3/2)] - \mu - g_i - g_j$

3- $S^{3}_{ijk} = (Y_{ijk...} / 3r\ p_3) - \mu - g_i - g_j - g_k - S_{ij} - S_{ik} - S_{jk}$

4- $S^{4}_{(ijkl)} = [(Y_{ijkl..}/(3r)] - \mu - g_i - g_j - g_k - g_l - S_{ij} - S_{ik} - S_{il} - S_{jk} - S_{jl} - S_{kl} - S_{ijk} - S_{ijl} - S_{jkl} - S_{jkl}$

5- $t^{2}_{(ij)(..)} = [Y_{(ij)(..).} /(r\ p_2 p_3/2)] - \mu - g_i - g_j - S_{ij}$

6- $t^{2}_{(i -)(j -)} = [Y_{(i .)(j .).} / r\ p_2 p_3] - \mu - g_i - g_j - S_{ij}$

7- $t^{3}_{(ij)(k -)} = [Y_{(ij)(k.).} / r\ p_3] - \mu - g_i - g_j - g_k - S_{ij} - S_{ik} - S_{jk} - S_{ijk} - t^{2}_{ij} - t^{2}_{i.k} - t^{2}_{j.k}$

$t^{4}_{(ij)(k l)} = [Y_{(ij)(kl).} / r] - \mu - g_i - g_j - g_k - g_l - S_{ij} - S_{ik} - S_{il} - S_{jk} - S_{jl} - S_{kl} - S_{ijk} - S_{ijl} - S_{ikl} - S_{jkl} - S_{ijkl} - t^{2}_{ij} - t^{2}_{kl} - t^{2}_{i.k} - t^{2}_{i.l} - t^{2}_{j.k} - t^{2}_{j.l} - t^{3}_{ij.k} - t^{3}_{ij.l} - t^{3}_{kl.i.} - t^{3}_{kl.j}$

Narrow sense heritability was estimated by the following equations:
$h^{2}_{ns} = \{ (1/4\ A + 1/8\ AA + 1/16\ AAA) / (1/4\ A + 1/8\ AA + 1/16\ AAA + 1/8\ D + 1/16\ AD + 1/32\ DD + E/3)\}$

Where, A = Additive, D= Dominance and E= Error variance

RESULTS AND DISCUSSION

The mean squares of genotypes and crosses were highly significant for all studied traits except (L. %). Furthermore, the partition of crosses sum squares to thier components (Table 2) showed that the mean square due to *1-line general* were highly significant for all studied traits except (L. %) suggesting the presence of the additive variance in the inheritance of these traits, subsequently the selection through the advanced segregating generations would be efficient to improve these characters.

The estimates due to *2-line specific* and *2-line arrangement* were significant or highly significant for all studied traits except (L. %) suggesting the presence of the non-additive variance in the inheritance of these traits. *3-line arrangement* mean squares were significant or highly significant for all studied traits. These results indicated that the contribution of additive by dominance interaction including all three factors or higher order interactions except all dominance types. Furthermore, the results indicated that tests of significant showed that the mean squares due to *4-line arrangement* were significant for most studied traits referred to the contribution of dominance × dominance genetic variances in the genetic expression of these traits and all three factor interactions, except all additive types.

General combining ability effects for each parental variety

The estimates of general combining ability effects (g_i) of parental varieties were obtained for yield and yield component traits and some fiber properties and the obtained results are shown in Table 3. Positive estimates would indicate that a given variety is much better than the average of the group involved with it in the quadriallel crosses for all studied traits except fiber fineness (desirable = negative value). Comparison of the general combining ability effect (g_i) of individual parent exhibited that no parent was the best combiner for all yield and its component traits and/or fiber properties. In multiple crossing programs prior information on the order effect of lines could be of great value (Singh and Chaudhary 1985).

Table 2: The analysis of variance of the double crosses for yield component traits and some fiber properties.

S .O .V	d f	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
Rep.	2	0.012	74.2	61.8**	11.39*	0.052	0.168	0.383
Crosses	44	0.167**	3203.2**	533.6**	3.63	0.297**	4.899**	1.327**
1_line general	5	0.234**	9401.4**	1544.9**	2.21	0.437**	7.224**	1.204**
2_line specific	9	0.099**	3283.4**	540.6**	1.64	0.629**	2.305*	1.077**
2_line Arrangement	9	0.159**	2724.2**	516.3**	4.18	0.151**	12.105**	0.693**
3_line Arrangement	16	0.197**	1143.8**	161.6**	4.59*	0.153**	3.074**	1.560**
4_line Arrangement	5	0.143**	4313.4**	731.5**	4.57	0.282**	0.109	2.291**
Error	88	0.023	29.0	12.6	2.62	0.045	0.877	0.151

Table 3: General line effect (g_i) for yield component traits and some fiber properties.

Parents	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
G.86	0.0116	5.0316	2.0342	-0.0148	0.0030	0.0813	0.1148
TNB1	0.0496	8.3771	3.2613	-0.1277	-0.0593	0.2396	0.0015
Suvin	0.0026	2.0219	0.9305	0.1080	0.0196	-0.0836	-0.0313
CB-58	-0.0487	-9.6123	-4.0362	-0.0870	-0.0426	0.0233	-0.0585
G.85	-0.0150	-3.0009	-1.0570	0.1157	0.0602	-0.2961	-0.0796
G.89	-0.0001	-2.8173	-1.1328	0.0058	0.0191	0.0355	0.0531

The parent TNB1 (P_2) was the best general combiner for most studied yield component traits and/ fiber properties such as seed cotton yield/plant (S.C.Y. /P.), lint yield/plant (L.Y. /P.) and boll weight (BW), fiber fineness (F.F.) and upper half mean (UHM). The variety Giza 86 (P_1) had the positive desirable values of general combining ability for the same previous traits except fiber fineness (F.F.) and the best combiner for fiber strength (F.S.). In addition, the results revealed that the variety CB-58 (P_4) was a good combiner among this group of varieties for fiber fineness (F.F.) which had a negative (desirable) value. Moreover, the variety Giza 85 (P_5) was the best combiner for lint percentage (L %). The parent Suvin (P_3) had a good combiner for all studied yield component traits. Thus, it could be suggested that these parental varieties would be utilized in a breeding program for improving these traits to pass favorable genes for improving hybrids and subsequently producing improved genotypes through the selection in segregating generations, Abd El-Bary (1999 and 2003), and Tuteja and Singh (2001).

Specific combining ability effects.

Two-line specific effects

The two-line interaction effect of lines i and j appearing together irrespective of arrangement (S^2_{ij}). It refers to the specific combining ability effect of the two lines used as the parents involved in the same single cross (first or second single cross) [(first and second) or (third and fourth) parent] or one of the two lines used as a parent involved in the first single cross and the second line used as a parent involved in the second single cross [(first and third) or (second and fourth) parent] for all combinations. The studied yield components traits and some fiber properties were obtained and the results are presented in Table 4. The results cleared that no hybrids exhibited desirable values for all studied traits. It could be noticed that (S^2_{12}), (S^2_{13}), (S^2_{15}), (S^2_{23}) and (S^2_{46}) showed positive (desirable) effects for most yield components. Moreover, the best combinations for (F.F) were (S^2_{12}), (S^2_{35}) and (S^2_{46}). Also, the best combinations for (F.S) and (UHM) were (S^2_{16}), (S^2_{23}) and (S^2_{46}), respectively.

Table 4: The 2-line interaction effect of lines i and j appearing together irrespective of arrangement S^2ij for yield component traits and some fiber properties.

S^2_{ij}	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
S^2 12	-0.007	4.126	1.600	-0.058	-0.054	-0.017	-0.048
S^2 13	0.026	4.010	1.688	0.042	0.000	0.062	0.030
S^2 14	-0.020	-3.409	-1.294	0.063	-0.014	-0.024	-0.002
S^2 15	0.011	2.270	0.998	0.050	0.082	0.012	0.079
S^2 16	0.001	-1.966	-0.959	-0.112	-0.012	0.049	0.056
S^2 23	0.022	4.906	1.980	-0.034	-0.003	0.099	0.081
S^2 24	0.003	-0.465	-0.305	-0.105	-0.029	0.022	0.006
S^2 25	0.004	0.725	0.308	0.008	-0.009	0.056	-0.024
S^2 26	0.028	-0.916	-0.323	0.061	0.036	0.080	-0.014
S^2 34	-0.005	-5.057	-2.047	0.054	0.032	0.073	-0.085
S^2 35	-0.029	0.038	0.024	0.000	-0.045	-0.229	-0.058
S^2 36	-0.012	-1.876	-0.715	0.046	0.036	-0.088	0.000
S^2 45	-0.006	-4.329	-1.820	-0.025	0.021	-0.088	-0.032
S^2 46	-0.022	3.647	1.431	-0.073	-0.052	0.041	0.055
S^2 56	0.005	-1.706	-0.567	0.083	0.012	-0.047	-0.044

Three-line specific effects

The three-line interaction effect of lines i, j and k appearing together irrespective of arrangement (S^3_{ijk}). It refers to the specific combining ability effect of any two lines used as the parents involved in any single cross and the third line used as a parent involved in the second single cross (as male or female) for all combinations. With respect to the studied yield components traits and some fiber properties, the results are presented in Table 5. The results showed that no hybrids exhibited desirable values for all studied traits. The combinations (S^3_{123}), (S^3_{125}), (S^3_{135}) and (S^3_{235}), (S^3_{246}), (S^3_{456}) showed great positive (desirable) effects for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.). In the same time, (S^3_{135}), (S^3_{145}), (S^3_{146}), (S^3_{156}), (S^3_{236}) and (S^3_{246}) were the best combinations for (F.S), while (S^3_{123}), (S^3_{156}), (S^3_{234}), (S^3_{246}) and (S^3_{346}) for (UHM) as well as [(S^3_{123}), (S^3_{124}), (S^3_{146}) and (S^3_{235})] for (F.F) property.

Table 5: The 3-line interaction effect of lines i, j and k appearing together irrespective of arrangement S^3ijk for yield component traits and some fiber properties.

S^3_{ijk}	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
S^3 123	0.019	7.899	3.194	-0.038	-0.044	0.064	0.035
S^3 124	-0.028	-1.013	-0.418	-0.023	-0.064	-0.134	-0.063
S^3 125	-0.007	3.652	1.494	0.009	0.018	0.042	-0.006
S^3 126	0.001	-2.287	-1.069	-0.063	-0.017	-0.007	-0.063
S^3 134	0.014	-3.602	-1.296	0.156	0.025	0.103	-0.065
S^3 135	0.009	4.968	2.075	0.023	0.009	-0.056	0.050
S^3 136	0.011	-1.244	-0.596	-0.057	0.010	0.012	0.041
S^3 145	0.003	-2.940	-1.097	0.083	0.082	-0.037	0.052
S^3 146	-0.028	0.738	0.223	-0.091	-0.071	0.020	0.073
S^3 156	0.018	-1.140	-0.476	-0.014	0.055	0.074	0.061
S^3 234	0.019	-0.877	-0.424	-0.049	0.028	0.134	0.031
S^3 235	-0.015	3.204	1.268	-0.059	-0.064	-0.027	0.036
S^3 236	0.020	-0.413	-0.077	0.078	0.075	0.027	0.060
S^3 245	0.006	-2.656	-1.206	-0.090	-0.004	0.001	-0.005
S^3 246	0.009	3.617	1.439	-0.047	-0.018	0.043	0.048
S^3 256	0.025	-2.750	-0.939	0.154	0.032	0.096	-0.074
S^3 345	-0.020	-5.817	-2.456	-0.017	-0.005	-0.126	-0.119
S^3 346	-0.023	0.183	0.081	0.018	0.017	0.034	-0.018
S^3 356	-0.032	-2.278	-0.838	0.053	-0.031	-0.249	-0.082
S^3 456	-0.002	2.755	1.118	-0.027	-0.032	-0.015	0.007

Four-line specific effects

The four- line interaction effect of lines i, j, k and l appearing together irrespective of arrangement (S^4_{ijkl}). It refered to the specific combining ability effect of any two lines used as the parents involved in any single cross and the other two lines used as parents involved in the second single cross (as male or female) for all double combinations.With respect to the studied yield components traits and some fiber properties were obtained and the results are presented in Table 6. The results revealed that no hybrids exhibited desirable values for all studied traits. The best double combinations for seed cotton yield/plant (S.C.Y. /P.), lint yield/plant (L.Y. /P.) was (S^4_{1235}). Moreover, (S^4_{2456}), (S^4_{1345}), (S^4_{1246}), (S^4_{1256}) and (S^4_{1456}) were the best double combinations for (B.W), (L. %), (F.F), (UHM) and (F.S), respectively.

Table 6: The 4-line interaction effect of lines i, j, k and l appearing together irrespective of arrangement S^4ijkl for yield component traits and some fiber properties.

S^4_{ijkl}	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
S^4 1234	0.029	0.700	0.488	0.129	-0.044	0.121	-0.106
S^4 1235	-0.016	23.369	9.461	-0.138	-0.133	0.064	0.171
S^4 1236	0.045	-0.373	-0.368	-0.105	0.044	0.008	0.041
S^4 1245	-0.038	-4.833	-1.942	0.025	0.068	-0.216	-0.021
S^4 1246	-0.075	1.093	0.199	-0.224	-0.216	-0.307	-0.062
S^4 1256	0.032	-7.580	-3.036	0.140	0.120	0.278	-0.166
S^4 1345	0.033	-8.308	-3.096	0.306	0.147	-0.035	-0.097
S^4 1346	-0.022	-3.200	-1.279	0.035	-0.028	0.225	0.006
S^4 1356	0.009	-0.158	-0.140	-0.100	0.014	-0.198	0.075
S^4 1456	0.013	4.320	1.748	-0.082	0.031	0.142	0.274
S^4 2345	-0.009	-8.112	-3.778	-0.327	-0.057	0.031	0.000
S^4 2346	0.037	4.780	2.017	0.050	0.184	0.250	0.200
S^4 2356	-0.022	-5.646	-1.880	0.289	-0.002	-0.176	-0.062
S^4 2456	0.065	4.977	2.100	0.033	-0.023	0.187	0.007
S^4 3456	-0.083	-1.031	-0.494	-0.031	-0.105	-0.373	-0.260

Two-line interaction effect of lines i and j due to particular arrangement

The specific combining ability effects $t^2{}_{(ij)}(..)$ refers to the specific combining ability effect of the two lines (i and j) used as the parents involved together in the same single cross for all combinations.The studied yield and yield component traits and some fiber propertiesfor two lines interaction were obtained and the results are presented in Table 7. The results indicated that no hybrids exhibited desirable values for all studied traits. The combinations $t^2{}_{(16)}(..)$, $t^2{}_{(16)}(..)$, $t^2{}_{(24)}(..)$, $t^2{}_{(56)}(..)$, $t^2{}_{(36)}(..)$, $t^2{}_{(16)}(..)$ and $t^2{}_{(15)}(..)$ were the best combinations for (S.C.Y. /P.), (L.Y. /P.), (L. %), (B.W), (F.F), (UHM) and (F.S) traits, respectively.

Table 7: The 2- line interaction effect of lines i and j due to particular arrangement t^2(ij)(..). for yield component traits and some fiber properties.

$t^2{}_{(ij)}$ (..).	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
t^2 (12)(..).	-0.018	-2.642	-1.525	-0.306	-0.065	0.252	0.134
t^2 (13)(..).	-0.024	-6.463	-2.721	0.204	0.064	0.245	-0.072
t^2 (14)(..).	0.099	-5.529	-2.664	-0.335	0.045	-0.018	-0.244
t^2 (15)(..).	-0.048	-0.531	0.642	0.466	-0.026	-1.574	0.281
t^2 (16)(..).	-0.009	15.165	6.268	-0.030	-0.019	1.096	-0.099
t^2 (23)(..).	0.123	8.412	4.078	0.256	-0.055	0.126	0.051
t^2 (24)(..).	0.032	5.941	3.701	0.864	0.056	0.278	0.248
t^2 (25)(..).	-0.042	-9.923	-5.511	-0.826	-0.056	0.413	-0.215
t^2 (26)(..).	-0.095	-1.787	-0.743	0.012	0.119	-1.069	-0.219
t^2 (34)(..).	-0.081	13.681	5.069	-0.471	0.030	-0.175	0.008
t^2 (35)(..).	0.063	6.297	2.617	-0.035	0.105	0.589	-0.118
t^2 (36)(..).	-0.081	-21.928	-9.044	0.046	-0.144	-0.785	0.131
t^2 (45)(..).	-0.104	-9.244	-3.687	0.183	-0.099	-0.135	-0.074
t^2 (46)(..).	0.055	-4.849	-2.419	-0.241	-0.032	0.050	0.061
t^2 (56)(..).	0.131	13.400	5.938	0.212	0.076	0.707	0.126

Two - line interaction effect of lines i and j due to particular arrangement

The specific combining ability effects $t^2_{(i.)(j.)}$ refers to the specific combining ability effect of the two lines (i and j) where i is a parent involved in the first single cross (as male or female) and j is a parent involved in the second single cross (as male or female) for all combinations. The studied yield component traits and some fiber properties were obtained and the results are presented in Table 8. The results showed that no hybrids exhibited desirable values for all studied traits. It could be noticed that $t^2_{(1.)(3.)}$, $t^2_{(2.)(5.)}$, $t^2_{(3.)(6.)}$ and $t^2_{(4.)(5.)}$ were the best combinations for most yield components. Meanwhile, $t^2_{(2.)(6.)}$, $t^2_{(3.)(5.)}$ and $t^2_{(5.)(6.)}$ were the best combinations for (F.F) property. Furthermore, $t^2_{(1.)(5.)}$, $t^2_{(2.)(6.)}$ and $t^2_{(3.)(6.)}$ were the best combinations for (F.S) property as well as $t^2_{(1.)(4.)}$, $t^2_{(2.)(5.)}$ and $t^2_{(2.)(6.)}$ were the best combinations for (UHM) property.

Table 8: The 2-line interaction effect of lines i and j due to particular arrangement t^2(i.)(j.). for yield component traits and some fiber properties.

$t^2_{(i.)(j.)}$	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
t^2(1.)(2.).	0.009	1.321	0.763	0.153	0.032	-0.126	-0.067
t^2(1.)(3.).	0.012	3.231	1.360	-0.102	-0.032	-0.122	0.036
t^2(1.)(4.).	-0.049	2.765	1.332	0.167	-0.023	0.009	0.122
t^2(1.)(5.).	0.024	0.265	-0.321	-0.233	0.013	0.787	-0.140
t^2(1.)(6.).	0.005	-7.582	-3.134	0.015	0.009	-0.548	0.050
t^2(2.)(3.).	-0.062	-4.206	-2.039	-0.128	0.027	-0.063	-0.025
t^2(2.)(4.).	-0.016	-2.970	-1.850	-0.432	-0.028	-0.139	-0.124
t^2(2.)(5.).	0.021	4.962	2.755	0.413	0.028	-0.206	0.107
t^2(2.)(6.).	0.048	0.894	0.371	-0.006	-0.059	0.534	0.109
t^2(3.)(4.).	0.041	-6.841	-2.535	0.235	-0.015	0.088	-0.004
t^2(3.)(5.).	-0.032	-3.149	-1.308	0.018	-0.052	-0.295	0.059
t^2(3.)(6.).	0.041	10.964	4.522	-0.023	0.072	0.392	-0.065
t^2(4.)(5.).	0.052	4.622	1.843	-0.091	0.050	0.068	0.037
t^2(4.)(6.).	-0.027	2.425	1.210	0.121	0.016	-0.025	-0.031
t^2(5.)(6.).	-0.065	-6.700	-2.969	-0.106	-0.038	-0.354	-0.063

Three-line interaction effect of lines i, j and k due to particular arrangement

The specific combining ability effects $t^3_{(ij)(k.)}$ refers to the specific combining ability effect of the three lines (i, j and k) where i and j are two parents involved together in the same single cross and k is a third parent involved in the another single cross for all combinations. The studied yield components traits and some fiber properties were obtained and the results are presented in Table 9. The results cleared that no hybrids exhibited desirable values for all studied traits. It could be noticed that $t^3_{(12)(4.)}$, $t^3_{(13)(2.)}$, $t^3_{(14)(6.)}$,$t^3_{(25)(1.)}$,$t^3_{(26)(3.)}$, $t^3_{(36)(1.)}$, $t^3_{(36)(1.)}$, $t^3_{(36)(4.)}$ $t^3_{(45)(2.)}$ and $t^3_{(46)(1.)}$, showed great positive (desirable) effects for seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.). Meanwhile, $t^3_{(13)(6.)}$, $t^3_{(23)(1.)}$, $t^3_{(26)(3.)}$, $t^3_{(34)(2.)}$, $t^3_{(35)(1.)}$ and $t^3_{(46)(1.)}$ were the best combinations for (F.F) property.

Moreover, $t^3(_{13})(_{5.})$, $t^3(_{14})(_{6.})$, $t^3(_{15})(_{3.})$, $t^3(_{26})(_{1.})$, $t^3(_{34})(_{1.})$, $t^3(_{36})(_{1.})$ and $t^3(_{46})(_{5.})$ were the best combinations for (UHM) property. In similar manner, $t^3(_{12})(_{5.})$, $t^3(_{13})(_{2.})$, $t^3(_{14})(_{2.})$, $t^3(_{24})(_{3.})$, $t^3(_{26})(_{4.})$, $t^3(_{45})(_{2.})$ and $t^3(_{56})(_{3.})$ were the best combinations for (F.S) trait.

Four-line interaction effect of lines i, j, k and l due to particular arrangement

The specific combining ability effects t^4 $(_{ij})$ $(_{kl})$ refers to the specific combining ability effect of the four lines (i, j, k and l) where [i and j] are two parents involved together in the first single cross and [k and l] are two parents involved together in the second single cross for all double combinations. Concerning the studied yield components traits and some fiber properties were obtained and the results are presented in Table 10. The results revealed that no hybrids exhibited desirable values for all studied traits. However, 15, 22, 22, 24, 21, 21 and 17 out of 45 quadriallel crosses showed desirable specific combining ability effects t^4 $(_{ij})(_{kl})$ values for boll weight (B.W.), seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), lint percentage (L. %), fiber fineness (F.F.), upper half mean (UHM) and fiber strength (F.S.), respectively. These quadriallel crosses involved [(poor x poor) x (poor x good)] or [(poor x poor) x (good x good)] or [(poor x good) x (good x good)] general combiners varieties, indicating to the presence of important epistatic gene action.

Thus, it is not necessary that parents having high general combination ability effect (gi) would also contribute to high specific combining ability effects t^4 $(_{ij})$ $(_{kl})$***.***For instance, in the crosses [(P_1 x P_2) x (P_3 x P_4)], [(P_1 x P_2) x (P_3 x P_6)], [(P_1 x P_3) x (P_2 x P_4)], [(P_1x P_5) x (P_2x P_3)] and [(P_1 x P_6) x (P_2 x P_3)] for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.), boll weight (B.W.), three out of four parents had the best general combining ability effects (g_i) as mentioned earlier,

, but these combinations gave comparatively low specific combining ability effects t^4 $(_{ij})(_{kl})$ for the same previous four traits. In contrast, the crosses [(P_1 x P_3) x (P_4 x P_5)], [(P_1 x P_4) x (P_5 x P_6)], [(P_2 x P_3) x (P_5 x P_6)], [(P_2 x P_4) x (P_3 x P_6)], [(P_2 x P_5) x (P_3 x P_4)], [(P_2x P_6) x (P_4x P_5)] and [(P_3 x P_5) x (P_4x P_6)] involved two or three out of four parents with poor general combining ability effects (g_i) for these traits, gave high specific combining ability effects t^4 $(_{ij})(_{kl})$ values for these traits.

Table 9: 3- line interaction effect of lines i, j and k due to particular arrangement t^3(ij) (k-) for yield component traits and some fiber properties

t^3 (i j)(k-)	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
t^3 (12)(3.).	-0.019	-10.063	-2.890	0.868	0.088	-0.196	-0.121
t^3 (12)(4.).	0.031	9.288	3.472	-0.190	-0.038	0.366	-0.286
t^3(12)(5.).	-0.027	3.587	0.558	-0.696	-0.020	-0.318	0.208
t^3 (12)(6.).	0.032	-0.170	0.385	0.324	0.035	-0.104	0.064
t^3 (13)(2.).	0.107	12.796	4.441	-0.638	0.023	0.078	0.350
t^3 (13)(4.).	-0.048	-1.146	0.555	0.541	-0.075	-0.664	-0.051
t^3 (13)(5.).	-0.039	0.567	0.283	0.138	0.100	0.519	-0.031
t^3(13)(6.).	0.004	-5.754	-2.558	-0.246	-0.112	-0.178	-0.195
t^3 (14)(2.).	-0.111	-9.443	-4.083	-0.111	-0.031	0.055	0.342
t^3 (14)(3.).	-0.083	6.909	1.794	-0.609	-0.063	-0.052	-0.050
t^3 (14)(5.).	0.082	0.207	1.359	0.871	-0.008	-0.529	0.054
t^3 (14)(6.).	0.014	7.856	3.595	0.184	0.057	0.544	-0.103
t^3 (15)(2.).	0.009	-11.408	-3.642	0.760	-0.012	0.430	-0.545
t^3 (15)(3.).	0.113	1.429	0.298	-0.285	0.012	0.610	-0.133
t^3 (15)(4.).	-0.019	4.859	0.990	-0.663	0.016	0.249	0.213
t^3 (15)(6.).	-0.054	5.650	1.712	-0.278	0.010	0.286	0.185
t^3 (16)(2.).	-0.013	6.733	2.522	-0.164	-0.012	-0.437	-0.080
t^3 (16)(3.).	-0.023	-1.506	-0.561	0.129	-0.005	-0.238	0.267
t^3 (16)(4.).	0.085	-15.765	-6.350	0.144	0.119	0.039	0.002
t^3 (16)(5.).	-0.040	-4.626	-1.879	-0.079	-0.084	-0.460	-0.090
t^3 (23)(1.).	-0.088	-2.733	-1.551	-0.230	-0.111	0.118	-0.229
t^3 (23)(4.).	0.024	-2.942	-1.583	-0.064	0.161	0.198	-0.010
t^3(23)(5.).	0.057	0.584	0.556	0.074	0.011	-0.001	0.087
t^3 (23)(6.).	-0.115	-3.321	-1.501	-0.036	-0.006	-0.441	0.101
t^3 (24)(1.).	0.080	0.155	0.611	0.301	0.069	-0.422	-0.056
t^3 (24)(3.).	-0.004	-0.040	-0.299	-0.326	-0.073	0.136	0.483
t^3 (24)(5.).	-0.125	-8.366	-4.222	-0.371	-0.062	0.117	-0.454
t^3 (24)(6.).	0.018	2.311	0.209	-0.468	0.009	-0.110	-0.221
t^3 (25)(1.).	0.018	7.820	3.085	-0.063	0.032	-0.112	0.337
t^3 (25)(3.).	0.111	6.259	2.664	0.153	0.045	-0.086	-0.143
t^3 (25)(4.).	-0.105	-4.443	-0.772	0.550	-0.044	-0.336	0.074
t^3 (25)(6.).	0.018	0.287	0.535	0.186	0.021	0.121	-0.054
t^3 (26)(1.).	-0.019	-6.563	-2.908	-0.161	-0.023	0.541	0.016
t^3 (26)(3.).	-0.026	8.050	2.564	-0.567	-0.088	0.209	-0.194
t^3 (26)(4.).	0.065	1.067	0.734	0.135	-0.051	-0.089	0.345
t^3 (26)(5.).	0.075	-0.767	0.353	0.580	0.044	0.408	0.052
t^3 (34)(1.).	0.131	-5.763	-2.349	0.068	0.138	0.716	0.100
t^3 (34)(2.).	-0.020	2.982	1.882	0.390	-0.088	-0.334	-0.474
t^3 (34)(5.).	-0.012	-3.279	-1.503	-0.122	-0.058	-0.142	0.074
t^3 (34)(6.).	-0.017	-7.622	-3.099	0.135	-0.021	-0.065	0.291
t^3 (35)(1.).	-0.073	-1.996	-0.581	0.147	-0.112	-1.128	0.164
t^3 (35)(2.).	-0.167	-6.844	-3.220	-0.227	-0.056	0.086	0.056
t^3 (35)(4.).	0.089	-3.191	-1.452	-0.055	-0.004	0.161	0.029
t^3 (35)(6.).	0.088	5.733	2.636	0.170	0.067	0.291	-0.132
t^3 (36)(1.).	0.019	7.260	3.119	0.117	0.116	0.416	-0.072
t^3 (36)(2.).	0.141	-4.728	-1.063	0.603	0.094	0.233	0.093
t^3 (36)(4.).	-0.106	14.120	5.015	-0.658	-0.067	0.217	0.036
t^3 (36)(5.).	0.027	5.276	1.973	-0.108	0.000	-0.081	-0.187
t^3 (45)(1.).	-0.063	-5.066	-2.350	-0.208	-0.008	0.280	-0.267
t^3 (45)(2.).	0.230	12.810	4.994	-0.179	0.105	0.219	0.380
t^3 (45)(3.).	-0.077	6.470	2.956	0.176	0.062	-0.019	-0.103
t^3 (45)(6.).	0.013	-4.970	-1.914	0.028	-0.061	-0.345	0.064
t^3 (46)(1.).	-0.099	7.909	2.755	-0.328	-0.176	-0.583	0.101
t^3 (46)(2.).	-0.083	-3.378	-0.942	0.333	0.042	0.199	-0.124
t^3 (46)(3.).	0.123	-6.498	-1.916	0.524	0.088	-0.152	-0.327
t^3 (46)(5.).	0.004	6.817	2.523	-0.287	0.078	0.486	0.289
t^3 (56)(1.).	0.094	-1.024	0.167	0.357	0.074	0.173	-0.094
t^3 (56)(2.).	-0.093	0.480	-0.888	-0.766	-0.065	-0.529	0.002
t^3 (56)(3.).	-0.115	-11.010	-4.609	-0.062	-0.068	-0.210	0.319
t^3 (56)(4.).	-0.017	-1.846	-0.609	0.259	-0.018	-0.142	-0.353

Table 10: The 4-line interaction effect of lines i, j, k and l due to particular arrangement t^4 (i j)(k l) for yield component traits and some fiber properties

t^4(i j)(k l)	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
t^4(12)(34)	-0.091	-9.259	-3.928	-0.086	-0.054	0.053	-0.216
t^4(12)(35)	-0.005	15.658	6.701	0.267	0.002	0.047	-0.207
t^4(12)(36)	0.096	-6.399	-2.773	-0.180	0.052	-0.100	0.423
t^4(12)(45)	0.096	-6.399	-2.773	-0.180	0.052	-0.100	0.423
t^4(12)(46)	-0.005	15.657	6.701	0.267	0.002	0.047	-0.207
t^4(12)(56)	-0.091	-9.259	-3.928	-0.086	-0.054	0.053	-0.216
t^4(13)(24)	-0.008	-15.137	-6.098	0.069	0.135	0.007	-0.171
t^4(13)(25)	0.010	0.629	-0.417	-0.449	-0.068	0.008	0.409
t^4(13)(26)	-0.001	14.508	6.515	0.381	-0.068	-0.015	-0.238
t^4(13)(45)	-0.001	14.508	6.515	0.381	-0.068	-0.015	-0.238
t^4(13)(46)	0.010	0.629	-0.417	-0.449	-0.068	0.008	0.409
t^4(13)(56)	-0.008	-15.137	-6.098	0.069	0.135	0.007	-0.171
t^4(14)(23)	0.100	24.396	10.026	0.018	-0.081	-0.060	0.387
t^4(14)(25)	0.002	-9.838	-3.091	0.755	0.160	0.003	-0.621
t^4(14)(26)	-0.102	-14.558	-6.935	-0.773	-0.079	0.057	0.234
t^4(14)(35)	-0.102	-14.558	-6.935	-0.773	-0.079	0.057	0.234
t^4(14)(36)	0.002	-9.838	-3.091	0.755	0.160	0.003	-0.621
t^4(14)(56)	0.100	24.396	10.026	0.018	-0.081	-0.060	0.387
t^4(15)(23)	-0.005	-16.286	-6.284	0.183	0.066	-0.055	-0.202
t^4(15)(24)	-0.099	16.237	5.863	-0.575	-0.212	0.097	0.198
t^4(15)(26)	0.104	0.050	0.420	0.392	0.146	-0.042	0.004
t^4(15)(34)	0.104	0.050	0.420	0.392	0.146	-0.042	0.004
t^4(15)(36)	-0.099	16.237	5.863	-0.575	-0.212	0.097	0.198
t^4(15)(46)	-0.005	-16.286	-6.284	0.183	0.066	-0.055	-0.202
t^4(16)(23)	-0.095	-8.109	-3.742	-0.200	0.016	0.115	-0.185
t^4(16)(24)	0.107	-1.100	0.234	0.506	0.077	-0.104	-0.027
t^4(16)(25)	-0.012	9.209	3.508	-0.306	-0.093	-0.011	0.212
t^4(16)(34)	-0.012	9.209	3.508	-0.306	-0.093	-0.011	0.212
t^4(16)(35)	0.107	-1.100	0.234	0.506	0.077	-0.104	-0.027
t^4(16)(45)	-0.095	-8.109	-3.742	-0.200	0.016	0.115	-0.185
t^4(23)(45)	-0.095	-8.109	-3.742	-0.200	0.016	0.115	-0.185
t^4(23)(46)	-0.005	-16.286	-6.284	0.183	0.066	-0.055	-0.202
t^4(23)(56)	0.100	24.396	10.026	0.018	-0.081	-0.060	0.387
t^4(24)(35)	0.107	-1.100	0.234	0.506	0.077	-0.104	-0.027
t^4(24)(36)	-0.099	16.237	5.863	-0.575	-0.212	0.097	0.198
t^4(24)(56)	-0.008	-15.137	-6.098	0.069	0.135	0.007	-0.171
t^4(25)(34)	-0.012	9.209	3.508	-0.306	-0.093	-0.011	0.212
t^4(25)(36)	0.002	-9.838	-3.091	0.755	0.160	0.003	-0.621
t^4(25)(46)	0.010	0.629	-0.417	-0.449	-0.068	0.008	0.409
t^4(26)(34)	0.104	0.050	0.420	0.392	0.146	-0.042	0.004
t^4(26)(35)	-0.102	-14.558	-6.935	-0.773	-0.079	0.057	0.234
t^4(26)(45)	-0.001	14.508	6.515	0.381	-0.068	-0.015	-0.238
t^4(34)(56)	-0.091	-9.259	-3.928	-0.086	-0.054	0.053	-0.216
t^4(35)(46)	-0.005	15.658	6.701	0.267	0.002	0.047	-0.207
t^4(36)(45)	0.096	-6.399	-2.773	-0.180	0.052	-0.100	0.423

c .In general, the preivous results indicated that the combinations [(P_1 x P_2) x (P_3 x P_5)] and [(P_1 x P_2) x (P_4 x P_6)] appeared to be the best promising double crosses for breeding toward most studied yield traits potentiality.

Therefore , [(P_1 x P_5) x (P_2 x P_4)], [(P_1 x P_5) x (P_3 x P_6)] and [(P_2 x P_4) x (P_3 x P_6)] would be good combinations for most studied yield traits and all fiber properties. Meanwhile, [(P_1 x P_4) x (P_2 x P_3)], [(P_1 x P_4) x (P_5 x P_6)] and [(P_2 x P_3) x (P_5x P_6)] would be the best for most studied yield traits and fiber strength (F.S.) property. In addition, the combinations [(P_1 x P_6) x (P_2 x P_3)], [(P_1 x P_6) x (P_4 x P_5)], [(P_2 x P_3) x (P_4 x P_5)] and [(P_2 x P_5) x (P_4 x P_6)] appeared to be the best promising for upper half mean (UHM) property. Most of these combinations involved at least one of the best general combiners for yield. This indicate that predications of superior crosses based on the general combining ability effects of the parents would generally be valid and the contribution of non-allelic interaction in the inheritance of these traits. These findings may explain the superiority of the double crosses over their four parents for these traits.

Genetic parameters:

The Genetic parameters estimates were obtained and the results are presented in Table 11. The results revealed that the magnitudes of dominance genetic variance (σ^2D) were positive and larger than those of additive genetic variance (σ^2A), for all studied traits except for (UHM) property.Concerning epistatic variances, additive by dominance genetic variance (σ^2AD) showed negative and considerable magnitude for all studied traits except for the same previous property (UHM). Moreover, additive by additive genetic variance (σ^2AA) showed negative and considerable magnitude for (SCY), (LY) and (FS) traits. While, dominance by dominance genetic variance (σ^2DD) and additive by additive by additive genetic variance (σ^2AAA) showed positive and considerable magnitude for all studied traits with the exception of the (UHM).

It could be concluded that fiber properties and yield components were mainly controlled by dominance by dominance (σ^2DD) and additive by additive by additive (σ^2AAA) epistatic variances. This finding may explain the superiority of most studied double crosses than their parents in most of yield components traits. Therefore, it would be recommended that production of double crosses to involved in the selection breeding programs is the desirable way for improvement these traits. These results are partially agreement with those obtained by Abd El-Bary (2003), Hemaida et al (2006) and Abd El-Bary (2013). The heritabilities ranged from 38.2% to 71.3% for (UHM) and (FF), respectively. Same results were obtained by Said (2011) and El-Feki *et a*l (2012).

Table 11: The estimation of genetic variances for yield components and some fiber properties

Genetic Parameters	B.W.	S.C.Y. / P.	L.Y. / P.	L. %	F.F.	U.H.M.	F.S.
σ^2A	-0.167	-2487.7	-375.8	-3.095	-1.284	-5.016	-1.190
σ^2D	0.153	33859.3	5928.7	3.887	1.520	-11.513	11.238
σ^2AA	0.037	-27274.7	-4843.5	0.489	0.438	21.487	-10.163
σ^2AD	-1.621	-136273.5	-23352.1	-22.678	-6.589	64.794	-54.975
σ^2DD	2.390	91194.2	15247.1	22.940	4.753	-22.626	44.584
σ^2AAA	3.242	272546.9	46704.3	45.356	13.178	-129.588	109.950
h^2 ns	67.1	70.6	70.5	58.2	71.3	38.2	70.7

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تحسين القطن المصرى باستخدام الجيل الثانى للهجن الزوجية

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اشتملت الدراسة على ستة أصناف من القطن الباربادنس وهى : جيزه 86 ، TNB1، Suvin ، CB-58 ، جيزه 85 و جيزه 89 و استخدمت هذه الاصناف في تصيم نصف دوري انتج 15 هجين ومنها تم الحصول علي 45 هجين زوجي بحيث ان كل هجين زوجي يشتمل علي اربع اباء مختلفة ومن الهجن الزوجية تم الحصول علي F_2 لها. وقد تم تقيم نسل الجيل الثانى للهجن الزوجية موسم 2010 فى تجربة مصممة بقطاعات كاملة العشوائية ذات ثلاث مكررات حيث احتوت المكررة على 45 وحده تجربية وكل وحده تجربية مكونه من ثلاث خطوط طول الخط 4م والمسافة بين الخطوط 70 سم وقد زرعت النباتات على مسافة 40 سم وتم خف التجربة على نبات واحد فى الجورة وأجريت عليها العمليات الزراعية الموصي بها بمحطة البحوث الزراعية بسخا حيث تم تجميع البيانات علي الصفات الآتية: محصول القطن الزهر للنبات ، محصول القطن الشعر للنبات ، وزن اللوزة ، معامل الحليج ، متانة التيلة ،نعومة التيلة، طول التيلة.

هذا ويمكن تلخيص النتائج المتحصل عليها من هذه الدراسة فى النقاط التالية:

- اختبار المعنوية لمتوسط المربعات الخاصة بالتراكيب الوراثية أشار إلى أن هناك اختلافا عالي المعنوية بين هذه التراكيب الوراثية لمعظم الصفات المدروسة كما أظهرت تجزئة متوسط المربعات الخاصة بالهجن لمكوناته أهمية وجود التباين المضيف و التباين غير التجميعي بكل مكوناته (التباين السيادى ، التباين التجميعي × السيادى، التباين السيادى × السيادى ، التباين التجميعي × التجميعي و التباين التجميعي × التجميعي × التجميعي).
- من خلال تحليل الهجن الرباعية كان أفضل الاباء قدرة عامة على التآلف التراكيب الوراثية الابوية جيزه 86 و TNB1 لصفات المحصول ومكوناته بالإضافة لصفة طول التيلة و التركيب الوراثي C.B 58 قدره عامة علي التالف اصفة نعومة التيلة و التركيب الوراثى سيوفن للصفات المحصولية , اما الصنف جـ 85 فقد كان افضل الاباء قدرة عامة على التآلف لصفة نسبة الشعر .
- **القدرة الخاصة علي التآلف :** توجد سبعة أنواع لها قدرة خاصة علي التآلف تندرج تحت ثلاث تحتها مجاميع كالتالي

المجموعة الاولي : قدرة خاصة بين سلالتين

1-في هذا النوع لا يهم ترتيب السلالتين سواءاً كانتا معا في نفس الهجين الفردى أو كل سلالة في هجين فردى مستقل وكانت افضل الأتحادات عند تواجد Suvin مع TNB1 أو جـ86 مع TNB1 أو جيزه 86- مع Suvin لمعظم صفات المحصول.

2-في هذا النوع يشترط وجود السلالتين معا في نفس الهجين الفردى وكانت أفضل الاتحادات عند تواجد Suvin مع TNB1 أو جيزه 86 مع جيزه 89 أو تواجد Suvin مع CB-58 لمعظم صفات المحصول.

3-في هذا النوع يشترط وجود إحدى السلالتين في هجين فردى والسلالة الأخري في الهجين الفردي الثاني وكانت افضل الأتحادات عند تواجد TNB1 في هجين فردى و جيزه 85 في هجين فردى آخر لنفس الهجين الزوجى لصفة متانة التيلة بجانب صفات المحصول كما كانت افضل الأتحادات عند تواجد Suvin في هجين فردى و جيزه 89 في هجين فردى آخر لنفس الهجين الزوجى لصفة طول التيلة بجانب صفات المحصول .

المجموعة الثانية : قدرة خاصة بين ثلاث سلالات

4-في هذا النوع لا يهم ترتيب السلالات (اي سلالتين في هجين فردي والسلالة الثالثة في الهجين الفردى الآخر) وكانت أفضل الاتحادات عند تواجد جيزه 89 مع TNB1 مع Suvin لمعظم صفات المحصول.

5-في هذا النوع يشترط وجود السلالتين الأولي والثانية في الهجين الفردى الأول والسلالة الثالثة في الهجين الفردي الثاني) وكانت افضل الاتحادات عند تواجد Suvin مع جيزه 89 في الهجين الفردى الأول و CB-58في الهجين الفردى الثانى لصفات المحصول .

المجموعة الثالثة : قدرة خاصة بين أربع سلالات

6-في هذا النوع لا يهم ترتيب السلالات (اي سلالتين في هجين فردي والسلالتين الأخريين في الهجين الفردى الأخر) وكانت أفضل الاتحادات عند تواجد جيزه 86 و TNB1 و Suvin و جـ 85 معا لمعظم صفات المحصول والتيلة أو تواجد TNB1 و 58 -CB و جـ85 و جـ89 معاً لصفات المحصول .

7-في هذا النوع يشترط وجود السلالتين الأولي والثانية في الهجين الفردى الأول والسلالتين الثالثة والرابعة في الهجين الفردي الثاني) وكانت أفضل الاتحادات عند تواجد CB-58 مع جـ86 في الهجين الفردى الاول و سيوفن مع TNB1 في الهجين الفردى الثانى أو تواجد CB-58 مع جيزه 86 في الهجين الفردى الأول و جيزه85 مع جيزه 86 في الهجين الفردى الثانى أو تواجد سيوفن مع TNB1 في الهجين الفردى الاول و جيزه 85 مع جيزه 89 في الهجين الفردى الثانى لصفات المحصول .

- أظهـرت الهجـن [(جيـزه 86 × جيـزه 85)(TNB1 × 58 C.B)] و [(جيـزه 86 × جيـزه 85)(Suvin × جيزه 89)] و (TNB1 × 58 C.B)][(Suvin × جيزه 89)] أفضل تراكيب لمعظم صفات المحصول وكل صفات التيلة في حين أظهرت التراكيب الوراثية [(جيزه 86 × 58 C.B)(TNB1 × Suvin)] و [(جيـزه 86 × 58 C.B)(جيـزه 85 × جيـزه 89)] و [(TNB1 × Suvin)](جيزه 85 × جيزه 89)] الافضل بالنسبة لمعظم مكونات المحصول و صفة متانه التيله وكانت الهجن [(جـ86 × حـ89)(suvin × TNB1)] و [(جيزه 86 × جيزه 85)(58 C.B × جيزه 85)] و[(Suvin × TNB1)][(58 C.B × جيزه 85)]و [(جيزه 85 ×TNB1) (C.B 58 × جيزه 89)] الفضل بين الهجن بالنسبه لصفه طول التيله .
- أوضحت النتائج أن قيم التباين السيادى كانت موجبة و أكبر من التباين التجميعي لمعظم الصفات المدروسة.
- بينت النتائج أن قيم التباين التجميعي × السيادى و التباين التجميعي × التجميعي × التجميعي تلعب دوراً هاماً فى توارث معظم الصفات المدروسة ولذلك يجب على مربى القطن أن يستخدم هذه النتائج من اجل استنباط سلالات عالية الإنتاج من خلال تصميم برنامج انتخابى بداية من الجيل الانعزالى الثانى و حتى الأجيال الانعزالية المتقدمة من الهجن الرباعية المتفوقة.

قام بتحكيم البحث

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